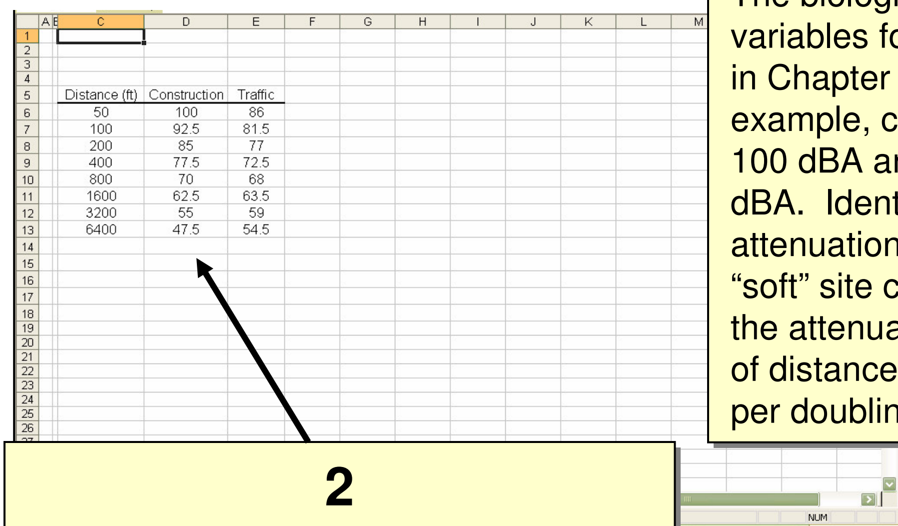
Noise Assessment Tutorial

The following guidance provides step-by-step instructions for obtaining and using the equations associated with conducting a noise assessment for WSDOT projects. This is companion guidance to Chapter 7 of the *WSDOT Biological Assessment Preparation for Transportation Projects* (BA Manual, available at http://www.wsdot.wa.gov/environment/biology/docs/BA_Manual.pdf). Both terrestrial and underwater noise examples are provided.

Terrestrial Noise – Trend Equations and Their Use

1

The biologist should first estimate the noise variables for the project using the guidance in Chapter 7 of the BA Manual. For this example, construction noise is estimated at 100 dBA and traffic noise is estimated at 86 dBA. Identify site conditions to determine the attenuation rates for noise – in this case, “soft” site conditions are assumed; therefore the attenuation rates are 7.5 dB per doubling of distance for construction noise and 4.5 dB per doubling of distance for traffic noise.



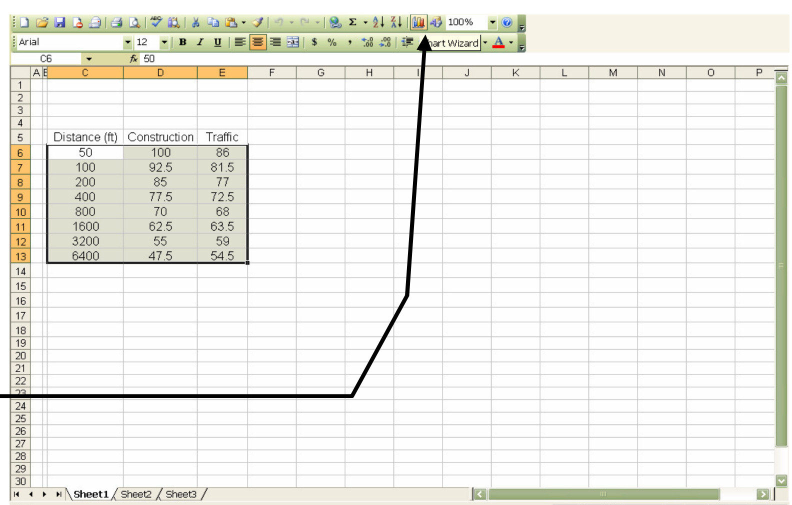
Distance (ft)	Construction	Traffic
50	100	86
100	92.5	81.5
200	85	77
400	77.5	72.5
800	70	68
1600	62.5	63.5
3200	55	59
6400	47.5	54.5

2

Once you have identified the estimated construction noise and traffic noise, use a spreadsheet program to build an attenuation table. Note the columns from left to right are distance, construction noise, and traffic noise. The distance should double every row, and the sound levels for construction and traffic will decrease by the attenuation rates identified in Step 1.

3

Select the data cells as shown (selection is highlighted) and click on a Chart Wizard button or select Insert Chart.



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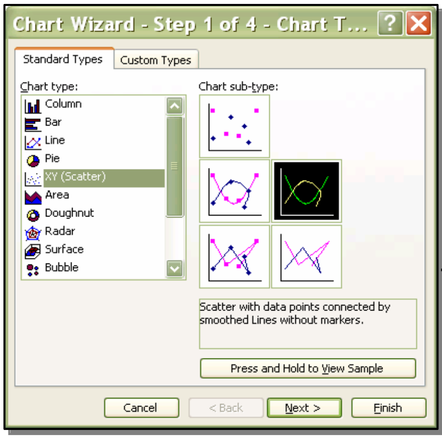
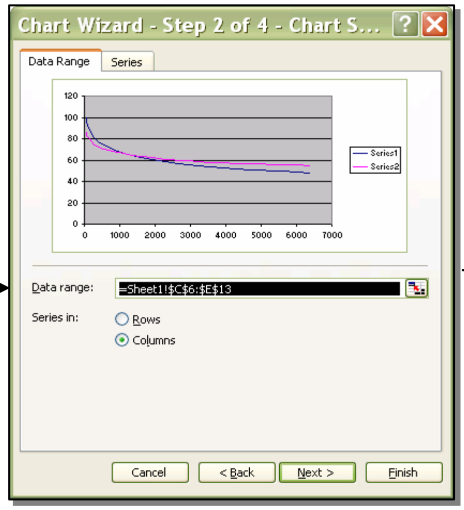
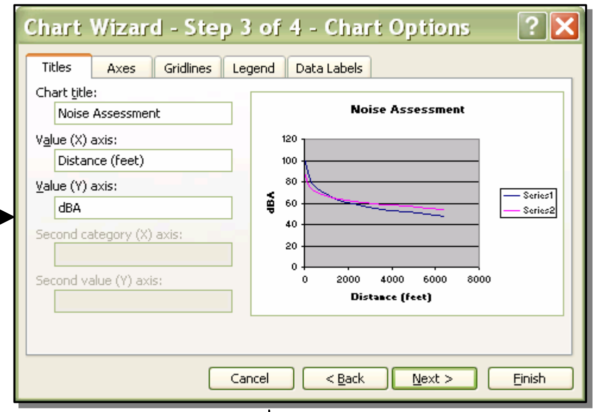
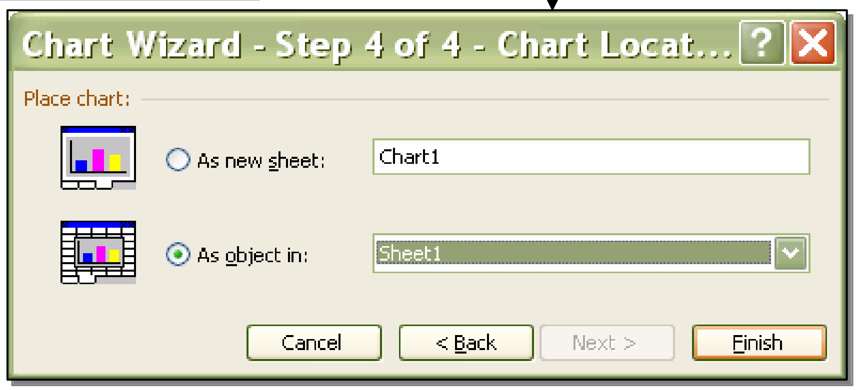


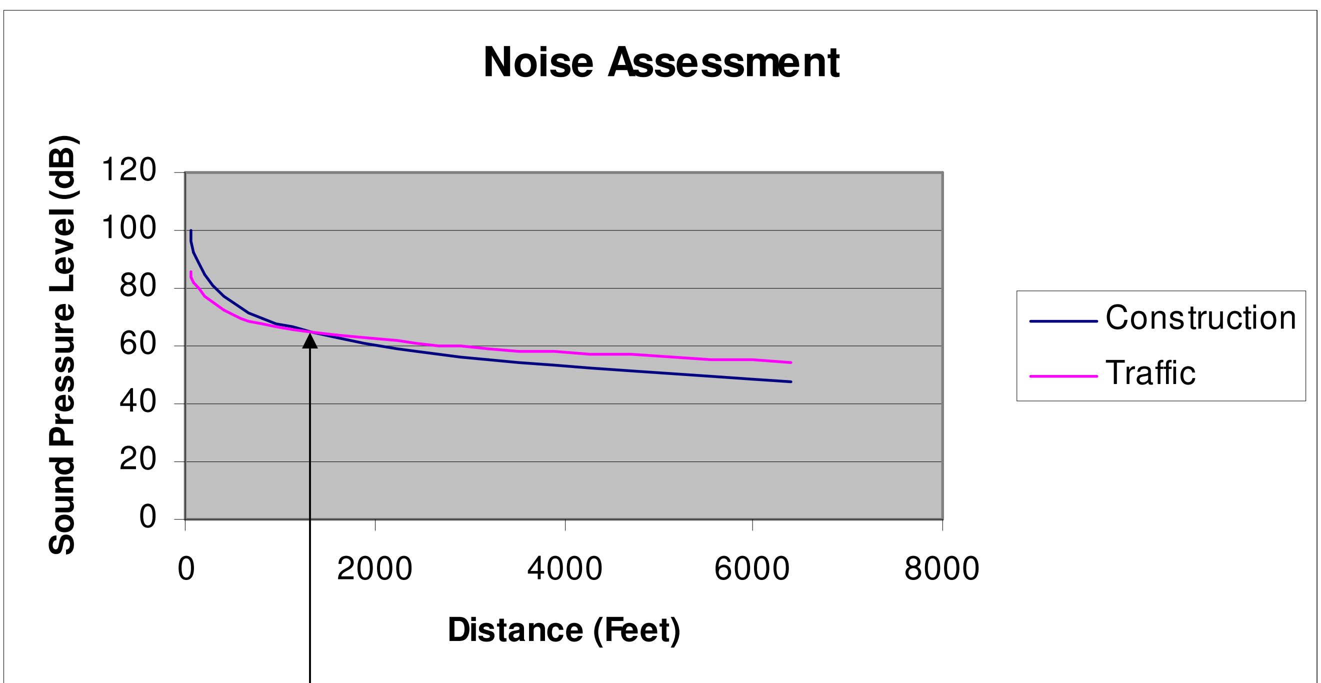




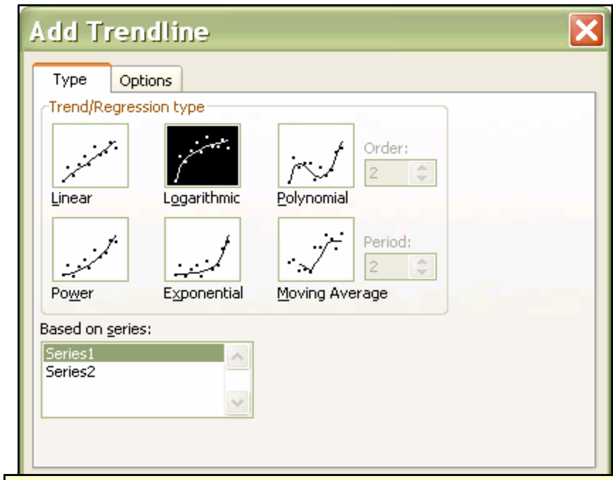
4

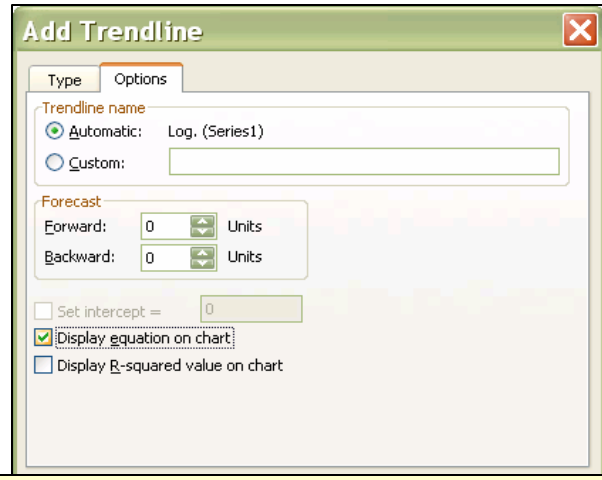
Select XY Scatter as the chart type. Label the chart if necessary. Finish the chart to display it on the spreadsheet.





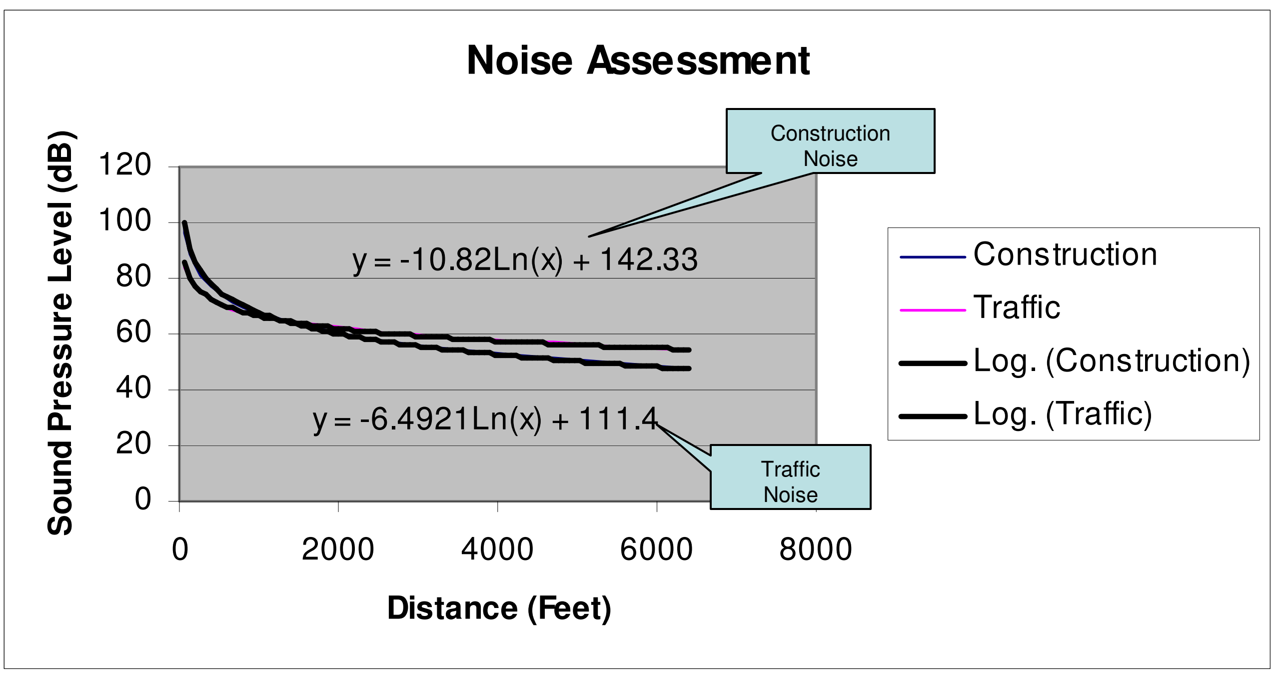
A chart is now displayed, showing two attenuation lines (construction and traffic). The location on the x-axis where the two lines cross is the limit of project-related noise. After this point, the baseline traffic noise is louder than construction noise.





5

The next step is to add a trendline for construction and traffic noise. Either select Add Trendline from the Chart menu, or right-click on the construction line in the chart and select Add Trendline. Make sure the trendline is logarithmic, and click the Options tab to display the equation on the chart. Add the trendline and the equation to the chart. Complete step 5 for each line to get trendlines and equations for construction and traffic noise.



Now that the equations have been identified, solve for either variable to determine the noise level at a given distance, or the distance from the source of a given noise level. The next page walks through examples using the trendline equations.

Example Construction Noise Trendline

$y = -10.82 \bullet Ln(x) + 142.33$

(Ln = natural log)

Example Traffic Noise Trendline

$y = -6.4921 \bullet Ln(x) + 111.4$

(Ln = natural log)

Solving for ***y*** will provide the decibel level at a known distance. Solving for ***x*** will yield the distance from the source a known decibel level will occur.

Note - These equations are not constant. You must graph the construction and traffic noise estimates for each specific project to get the correct equations.

Example – A spotted owl nest site is located 650 feet from the project. What is the expected construction noise level at the nest site? Solve the equation for y, which from the chart above is decibel level.

•Substitute 650 for x in the construction trendline equation

$y = -10.82 \bullet Ln(650) + 142.33$ **LN** **650**

$y = -70.080841 + 142.33$

y = 72 dBA

Calculator buttons

Example – The known baseline noise level in the project vicinity is 55 dBA. At what distance will construction noise attenuate to this level? Solve the equation for x, which in the chart above is distance.

•Substitute 55 for y in the construction trendline equation

$55 = -10.82 \bullet Ln(x) + 142.33$ *subtract 142.33 to the other side*

$-87.33 = -10.82 \bullet Ln(x)$ *divide both sides by -10.82*

$8.07 = Ln(x)$ *to get x alone, take the exponent of both sides* **e^x** **8.07**

x = 3,197 feet

Underwater Noise

Practical Spreading Loss and Nedwell Linear Equations

The US Fish and Wildlife Service and National Marine Fisheries Service currently recognize the Practical Spreading Loss equation as the best method to determine underwater noise attenuation rates. The Federal Highway Administration recommends the use of a linear equation developed by Nedwell. WSDOT recommends using **both** equations in the project noise assessment, and defining a more realistic impact zone based on site-specific factors. The following steps will guide the biologist through the use of both equations.

Practical Spreading Loss

$$TL = 15 \bullet \mathrm{Log}(R_1/R_2)$$

Where TL is the transmission loss in dB, R_1 is range in meters of the sound pressure level, and R_2 is the distance from the source of the initial measurement.

Solving for **TL** will provide the underwater sound pressure level at a given distance. To determine at what distance or range a known sound pressure level will occur, the equation must be solved for R_1:

$$R_1 = (10^{(TL/15)}) \bullet R_2$$

Example – A project is impact pile driving 30-inch hollow steel piles, which are expected to produce sound pressure levels of 190 dBrms 10 meters from the pile. What is the underwater sound pressure level 1,500 meters from the pile? Solve the equation for Transmission Loss, and subtract the TL from the initial sound pressure level.

$TL = 15 \bullet \mathrm{Log}\ (R_1/R_2)$ LOG 150

$TL = 15 \bullet \mathrm{Log}\ (1500m/10m)$

$TL = 15 \bullet 2.176$

TL = 33 dBrms

Subtract 33 dBrms from the initial sound pressure level of 190 dBrms to get the sound pressure level at 1,500 meters **= 157 dBrms.**

Example – A project is impact pile driving 30-inch hollow steel piles, which have been documented to produce sound pressure levels of 190 dBrms 10 meters from the pile. The underwater baseline noise level in the area is 135 dBrms. At what distance will pile driving noise attenuate to baseline levels? Solve the equation for distance using the known transmission loss.

$R_1 = (10^{(TL/15)}) \bullet R_2$ *TL = 190 – 135 = 55* | 10^x | 3.67

$R_1 = (10^{(55/15)}) \bullet R_2$

R1 = 4,677 ● 10m

R1 = 46,770 meters

For this example project, the extent of project-related noise would be estimated at 46,770 meters from project activity.

Nedwell Linear Equation

$SPL = SL – N_a (R)$

Where SPL is the sound pressure level, SL is the source sound level measured at some distance from the pile, N_a is the transmission loss rate, and R is the range or distance from the pile in meters.

The equation uses two different transmission loss rates (N_a): 0.07 dB/meter in river systems, and 0.15 dB/meter in marine waters. Solving for SPL will provide the sound pressure level at a given distance. To determine at what distance a given sound level will occur, the equation must be solved for R:

$R = (SL – SPL)/N_a$

Example - A project is impact pile driving 30-inch hollow steel piles in the marine environment, which are expected to produce sound pressure levels of 190 dBrms 10 meters from the pile. What is the underwater sound pressure level 500 meters from the pile?

$SPL = SL – N_a (R)$ *SL is 190 dBrms, Na is 0.15 dB/meter, and R is 500 meters*

SPL = 190 dBrms – (0.15 dB/m●500m)

SPL = 190 dBrms – 75 dBrms

SPL at 500 meters = 115 dBrms

Example - A project is impact pile driving 30-inch hollow steel piles in the marine environment, which have been documented to produce sound pressure levels of 190 dBrms 10 meters from the pile. The underwater baseline noise level in the area is 135 dBrms. At what distance will pile driving noise attenuate to baseline levels?

$$\mathbf{R = (SL - SPL)/N_a}$$ *SL is 190 dBrms, SPL is 135 dBrms, and Na is 0.15 dB/m*

R = (190 dBrms – 135 dBrms) / 0.15 dB/m

R = 55 dBrms / 0.15 dB/m

R = 367 meters

For this example project, using the linear equation, the extent of project-related noise is estimated at 367 meters from project activity.

The examples above compared the Practical Spreading Loss method with the Nedwell Linear method. Note the difference between the two methods is substantial. Using the Practical Spreading Loss equation, it takes over 46,000 meters to attenuate to ambient levels, while the same attenuation is estimated using the Linear equation at 367 meters.

For more information, see Chapter 7 of the BA Manual. WSDOT recommends using both methods for the project noise assessment, then refining the extent of project-related noise based on site-specific factors.